PUMP APPARATUS FOR FLUID SAMPLING AND COLLECTION, AND THE LIKE

This application is a continuation-in-part of U.S. application Ser. No. 07/522,629, filed May 14, 1990 which is a continuation of U.S. application Ser. No. 07/436,546, filed Nov. 14, 1989, now U.S. Pat. No. 4,998,585. This application is also related to U.S. Pat. Nos. 4,489,779; 4,585,060; and 4,727,936.

BACKGROUND AND SUMMARY OF THE INVENTION

The invention relates generally to fluid pumping and collection apparatuses. More particularly, the present invention relates primarily to such apparatus for pumping, recovering, collecting, or controlling fluids such as groundwater samples, condensate, hazardous leachate materials, or contaminated fluids from sources such as contaminated landsites having one or more in-ground wells, for example, or to or from tanks or other vessels. It should be noted, however, that the invention is also applicable and adaptable in various other applications that will occur to one skilled in the art from the disclosure herein, and that the invention allows for pumping in substantially any pump orientation.

Recent increases in public concern for the environment have resulted in various government-imposed environmental regulations with regard to groundwater quality and landsite cleanup projects. Among such regulations are requirements relating to the monitoring and sampling of groundwater quality. In response to these requirements, water quality analytic capabilities have ben improved and water sampling equipment has been developed. Much of the previously-developed sampling equipment has not been effective, however, in obtaining consistent, non-contaminated water samples that are accurately representative of the water system from which the sample is taken. Such ineffectiveness is especially acute in situations where vertical pump orientations are impossible or impractical.

The inadequacies of previous sampling equipment stem largely from causes such as cross-contamination between sampling sites, ineffective and inconsistent field cleaning methods, contamination due to equipment handling, and inconsistent well depth sampling. In addition to present sample quality problems, much of the previous equipment has been heavy and bulky and thus difficult to transport from one monitoring site to another. Finally, much of such previous equipment has proved to be complicated to operate, inordinately expensive, impractical for sampling at remote locations where site access is severely limited, and/or unusable in applications that require pump orientations other than substantially vertical.

The cleanup of toxic or otherwise hazardous materials from contaminated dump sites has also presented monumental environmental problems, especially in terms of safety, effectiveness, and economics. Many of the hazardous materials present in such contaminated landsites, or other fluid materials in other applications, are difficult and dangerous to handle, convey, and collect, especially in situations where the fluid is practically inaccessible to pumping equipment that requires a vertical orientation, as well as often being highly aggressive and corrosive to many materials commonly used for removal and collections equipment construction. In addition, many hazardous materials give off, or

are accompanied by, explosive gases, making the use of conventional electrically-operated equipment at contaminated landsites dangerous and undesirable. Finally, because of the potentially dangerous nature of many of the hazardous materials at such landsites, human intervention in the operation and maintenance of cleanup systems and equipment must be minimized.

In response to the groundwater monitoring and hazardous waste cleanup problems discussed above, the above-mentioned issued patents and co-pending applications relate to fluid sampling apparatuses provided for use in obtaining accurate samples of groundwater or other fluids. In one preferred embodiment of the disclosed groundwater sampling equipment, for example, a groundwater sampling pump is dedicated to a particular monitoring well or other sampling site in order to substantially avoid cross-contamination of samples for site-to-site and is constructed from lightweight, non-contaminating materials.

One of the preferred pumps for sampling or other pumping applications is a submersible, fluid-actuated pump wherein the actuating fluid is preferably a gas such as air. A flexible bladder member in this type of pump separates and isolates the interior of the pump into two chambers; a first chamber that contains the sample fluid and is in communication with both the pump inlet and outlet, and a second chamber surrounding the first chamber, and connected to a source of the actuating gas, with the bladder disposed therebetween. The pumped fluid is conveyed through the pump by alternately pressurizing and venting or relieving the pressure in the second chamber to contract and relax the bladder member, thus alternately decreasing and increasing the volume of the first chamber. The pumped fluid is drawn into the first chamber during such increases in volume under the influence of the natural hydrostatic head of the groundwater or other pumped fluid and is discharged through the pump outlet during such decreases in volume, thereby conveying the pumped fluid through the pump. The components of this pump are preferably composed of low-cost, lightweight synthetic materials that are non-corrosive and do not otherwise affect the chemical composition of the sampled fluid, but other materials, such as stainless still can alternately be used in appropriate liquid pumping applications. In this regard, it should be stressed that the present invention is not limited to such bladder-type pumps and is equally applicable to other types of pumps.

In order to allow the pump to be used in non-vertical orientations, that is in orientations greater than approximately 30 degrees from vertical, the preferred pump (whether a bladder-type or a non-bladder pump) includes rather unique reed-type check valves that render the pump functional in such non-vertical orientations, in substantially horizontal orientations, or even in inverted orientations. Such reed check valves are primarily used in gas conveying applications, but have been found to be highly advantageous in liquid pumping applications, according to the present invention, due to the fact that such reed check valves require only very low pressure levels to operate. In contrast, conventional check valves capable of functioning in non-vertical orientations, such as those employing a ball-and-seat arrangement with a spring return, require much higher pressures in order to function.

Also, in applications requiring substantially horizontal pump applications, the pump can include a flexible